Draft Flyer for Proposed CHAPMAN CONFERENCE (version 3/14/03)

Radiated Energy and the Physics of Earthquake Faulting

Date
Location
Web site

CONVENERS

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OBJECTIVES

The energy radiated by an earthquake is of considerable interest because it has the potential to provide valuable information concerning the inner workings of the seismic source. Realizing this potential remains somewhat elusive, however, despite the lengthy history of efforts to estimate and analyze seismic energy. Indeed, energy radiated from earthquakes is surprisingly controversial in many ways including its measurement, its scaling behavior, and the interpretation of this behavior in terms of the physics of faulting. Ideally, different techniques for estimating the seismic energy radiated by a given earthquake should yield similar results, but, in fact, discrepancies of an order of magnitude are not uncommon. Partly due to this measurement uncertainty, the question of how the radiated energy scales with earthquake size remains unanswered. Resolving this question is critical to closing a major gap in our understanding of the physics of earthquakes. That is, are large and small earthquakes different in terms of their physics of faulting? These basic questions persist despite improvements in seismic, geodetic and geological documentation of earthquakes that have spawned new techniques for describing these events at very high resolution. Instead of leading toward a consensus understanding of how earthquakes work, these impressive data sets have not as yet provided the means to resolve disagreements concerning some of the most essential aspects of the earthquake source and its relationship to the tectonic environment. For example, although we know that earthquakes are the result of elastic strain energy release in the lithosphere that is consumed by the work of overcoming fault friction, propagating the rupture, and radiating seismic waves, our understanding of these processes is only qualitative; the partition of released energy into these various components is highly uncertain. Debates on all these issues are at a very profound level in spite of ever-improving technology both in the field and laboratory.

This conference will bring together earth scientists who are enthusiastic about working to resolve these fundamental questions involving our understanding of the mechanics of earthquakes, from the physics of fault rupture to the radiated energy that is often associated with damaging ground motion. The conference will emphasize seismology, geology, laboratory rock mechanics, geophysics, geochemistry and the numerical modeling of earthquakes.

Topics for discussion will include:

- How best to measure the energy radiated from an earthquake. What are the advantages, disadvantages and uncertainties of the various methods and data sets used for measuring seismic energy? How can the state-of-the-art be improved so that results from different techniques are in better agreement and, thus, more credible?
- How does seismic energy scale with earthquake size? Does the ratio of radiated energy to seismic moment change systematically with increasing moment? If so, are these changes related to the earthquake source?
- Is it feasible to bridge the gap between laboratory "earthquakes" and natural tectonic earthquakes? What types of laboratory seismic phenomena are the most realistic earthquake analogs? To what extent does laboratory evidence support the idea that large earthquakes differ from small ones in terms of their physics of faulting?
- What insights can be gained from geological investigations of exhumed fault zones concerning the physics of earthquake fault slip? How compelling is the field evidence for high temperature effects such as melting or fluid pressurization? What have we learned from analyzing data yielded by deep drilling into active fault zones concerning our understanding of the energy budgets of earthquakes and the roles of pore fluids in the physics of faulting?
- How can the various models that have been used to simulate the earthquake rupture process be used to investigate the issue of the physics of faulting and its possible dependence on earthquake magnitude? To what extent can seismological, laboratory, and geological observations be used to constrain the parameters used in these rupture models, including the behavior of the coefficient of friction during fault slip?
- How efficient is the "earthquake machine"? Of the energy released during faulting, what fractions are consumed in extending the rupture, overcoming fault friction, and radiating seismic energy?
- Are large and small earthquakes different in terms of their physics of faulting? If such changes are real, what determines the magnitude threshold at which they take place? Possibilities include (1) thermal effects (e.g., melting) that set in because of large slip and its associated frictional heating and (2) differences associated with the contrast between frictional sliding and fresh rock fracture.